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U.S. SOIL CONSERVATION SERVICE
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Hugh G. Calkins, Regional Conservator

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INSTRUCTIONS

FOR

MAKING PLANT SURVIVAL SURVEYS

IN REGION 8

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C O N T E N T S

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TREE AND SHRUB CUTTINGS AND ROOTED STOCK

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INSTRUCTIONS FOR MAKING PLANT SURVIVAL SURVEYS

IN REGION 8

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PART I

TREE AND SHRUB CUTTINGS AND ROOTED STOCK

INTRODUCTORY

Purpose of Survival Surveys

The purpose of these instructions is to present the policy of the Washington Office and Region 8 and to effectuate the standardization of methods used in this Region to insure reasonably accurate and uniform results. These surveys will provide basic information on survival which will in part allow the reasoned development of future tree and shrub plantings.

Object of the Work

The object of this phase of plant survival survey work is to obtain information: (1) concerning the survival of trees and shrubs as related to species, type of stock, planting methods, soil conditions, planting costs and various other factors, and (2) to determine the point where replanting is justified.

The reason that statistical methods are used is to save time and money in securing usable information on plant survival.

Coverage

Many past plantings have been of an experimental nature to determine application in effectuating soil and water conservation. Where adequate data are available, only past plantings of those types which now appear justifiable in the light of the primary purpose of planting as

stated should be checked by survival surveys. All future plantings will be subject to study except where many plantings of one type occur under uniform conditions within a given locality. Here a proper mechanical selection of sufficient individual planting areas should be made. Survival studies of these selected areas will give a reasonable cross section of survival results for the locality.

Kind of Data to be Collected

The following outline indicates the character of data which should be collected for each survival survey:

(1) Map. The location of the survival counts and the survival results together with the date of the count will be shown on the planting map.

(2) Survival Analysis Form #3. This sheet gives the preliminary and final survival data for one examination.

(3) Planting Record and Survival Form #4. This gives the information necessary for an intelligent evaluation of the planting.

(4) A summary table. This gives a summary of plantings, survivals, replanting, and costs.

Intensity of Field Work

The intensity of field work will depend upon the degree of accuracy required, the size of the planting, and the information desired, as well as upon the amount of time and money available. The initial survey will cover not less than ten samples of 25 individuals each well distributed over the planting area. The final count, if needed, should cover the area in more detail, the number of samples depending upon the accuracy required. The final standard error of the mean must not exceed ± 5% for these surveys.

Plantings containing 1000 or more individuals will be treated statistically, those with less than 1000 individuals will have the actual survival percentage determined. These small plantings should be isolated and not directly related to any other planting.

Survival surveys will be made following the critical periods and before the leaves have fallen. One and often two survival surveys will be necessary annually.

SAMPLING

Method

The size and number of samples required to establish beyond a reasonable doubt the significance of a difference in the average survival

of various stands of plantings will depend upon the uniformity of the stands to be sampled. The more uniform the stands obtained, the smaller will be the deviation or scatter in the survival percentages for the individual sample plots taken in each planting, and as a consequence the number and/or size of samples needed for a desired degree of accuracy will be smaller. The basis for significant results lies in the uniformity of the population sampled as well as in the number and size of the plots examined. The sample taken must be of sufficient size to be representative of the entire planting under consideration. These factors cannot be arrived at by guess since such a practice gives no measure of the reliability, nor assurance that the results are significant.

It is essential, therefore, that the selection of the individual samples or plots be by pure chance in order to secure a representative cross-section of the population, in this case the planting. The best method, by which to secure a representative sample, is through the use of "mechanical sampling". This will give results which are essentially free from personal desires, prejudices, or bias, especially when the basic data are faithfully recorded.

The most satisfactory method of mechanical sampling results when the plots are evenly distributed over the entire area of the planting under consideration. This may be done by gridironing the area and then checking the survival or stand obtained on small samples of uniform size, equidistant along the grid lines.

In the case of trees and shrubs, a definite number of individual plants may be checked for survival. For those arranged in rows, satisfactory samples may be secured by counting all the individuals in certain selected rows, such as every 3rd or 5th row. In the gridiron system the point of intersection is located on the ground and then a designated number of plants counted; care must be taken that the plants are well distributed about the point of intersection or that the block of plants always lies in the same position in regard to the point of reference. In such cases 25 plants should be sufficient and would readily give the survival percentage. Where small, intermittent plantings occur, as in gullies, it may be most satisfactory to determine the survival of from one to several samples for each separate area and then make an analysis of the entire set-up. Attention must be paid to conditions since these may alter the results. Gullies having narrow, continuous plantings of considerable length may be treated mechanically by taking a sample at definite intervals, making either counts of individuals or plot determinations for survivals. In this case the size of the plot will not be uniform, but should extend from one side of the planting to the other, thus all conditions will be sampled.

The size and distribution of the samples for survival studies will depend upon the planting in question and will necessarily be determined by the individual conducting the survey.

The gridiron method is the most feasible for large areas over which conditions are essentially the same. The area to be studied is divided into blocks of uniform size and of sufficient frequency. In the diagram the dots indicate the points of intersection, the dots with the added open square indicate the samples taken during the initial survey, the blackened squares indicate the additional samples required for the final survey.

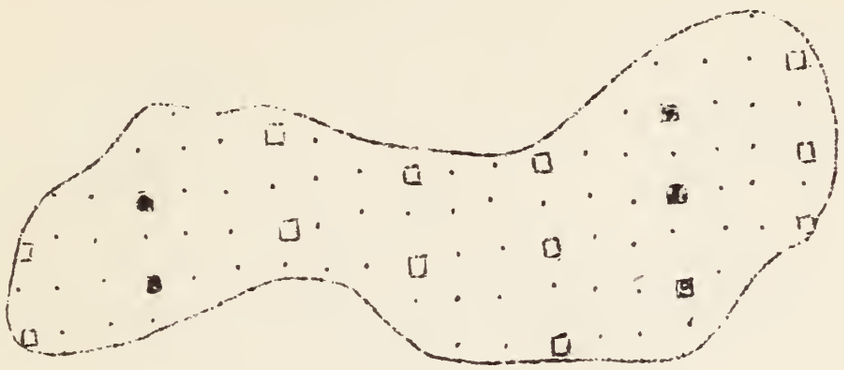


Fig. 1

Example of gridding for survival with reference to row counts on large areas, the lines represent the rows, the cross-bars and heavier portion indicate the location of the samples, additional samples should be located mechanically as shown by the crosses.

Fig. 2

Example of a continuous gully planting. The bands enclose the sample.

Fig. 3

Where several samples are taken in the band the average results should be recorded.

Example of vegetative filters, willow plantings across washes - those marked by the crosses are examined for survival, the rest ignored. Additional samples must be selected mechanically.

Fig. 4

Example for sampling intermittent plantings in a wash. The spaces outlined are the plantings, the bands or starred areas are the samples. If such plantings are in numerous small washes, it is permissible to select by mechanical means certain of the washes upon which the analysis will be made.

Fig. 5

Twenty-five individuals, living and dead, willconstitute a sample, the number of living individuals multiplied by four gives the percentage survival. Where all the individuals or odd numbers of trees or shrubs are counted the survival percentage is found by dividing the number of living plants by the total dead and living plants. Separate analysis sheets must be kept for each species planted. When replanting occurs, supplemental planting and survival records must be made for the additional new plants.

Analysis of Results

1. Record the field survival percentages in the proper classes as shown in Form #3.

2. Proceed with the necessary computations as shown on Form #3.

SYMBOLS

A - Guessed average or mean

M - Mean or average

N - Number of samples

D - Deviation from the guessed mean, the scatter

S - Sum of

σ - Standard deviation, the scatter

σ_E - Standard error of the mean

a. Select the "guessed mean" A; i.e. 45.0.
b. In column 3 call this Zero. Classes less than 45.0 are minus, greater than 45.0 are plus. Use 10 for the deviation since that represents the range of the classes.
c. Compute column 4 as indicated, add.
d. Compute column 5 as indicated, add.
e. Obtain the mean, M, by formulae, $M = \frac{SND}{N} + A$
Mean survival is 42.0%.
f. Determine the standard deviation, σ , as follows:

$$\sigma = \pm\sqrt{\frac{SND^2}{N} - \left(\frac{SND}{N}\right)^2} = \pm 14.2\%$$

This means that 68% of the cases lie between 27.8% and 56.2%. The result is usually expressed as follows: 42.0% $\pm$ 14.2%.

S.C.S. Revegetation Form No. 3

Survival Analysis

Cottonwood
Gully Planting

See Record Sheet N.4R.L.

1	2	3	4	5
Class	Number N	Deviation D	2 x 3 ND	ND^2 3x3x2
0 - 10	0	-40	-0	0
10 - 20	1	-30	-30	900
20 - 30	1	-20	-20	400
30 - 40	2	-10	-20	200
40 - 50	3	0	-70	0
50 - 60	2	+10	+20	200
60 - 70	1	+20	+20	400
70 - 80	0	+30	+0	0
80 - 90	0	+40	+0	0
90 - 100	0	+50	+0	0
			40	
			-70	
Sums	N = 10	---	-30 = SND	2100=SND^2

Class	Number	Deviation	ND	ND^2
0 - 10				
10 - 20				
20 - 30				
30 - 40				
40 - 50				
50 - 60				
60 - 70				
70 - 80				
80 - 90				
90 - 100				
Sums				

$$M = \frac{SND}{N} + A = \frac{-30}{10} + 45$$

$$-3.0 + 45 = 42.0\%$$

$$\sigma = \sqrt{\frac{SND^2}{N} - \left(\frac{SND}{N}\right)^2} = \sqrt{\frac{2100}{10} - \left(\frac{-30}{10}\right)^2}$$

$$= \sqrt{210 - (-3)^2} = \sqrt{210 - 9} =$$

$$\sqrt{201} = \pm 14.2\%$$

$$\sigma_E = \frac{\sigma}{\sqrt{N-1}} = \frac{14.2}{\sqrt{10-1}} = \frac{14.2}{\sqrt{9}}$$

$$\frac{14.2}{3} = \pm 4.73\%$$

$$N = \left(\frac{\sigma}{\sigma_E}\right)^2 = \left(\frac{14.2}{5}\right)^2$$

$$(2.84)^2 = 8.$$

Since $\sigma_E = \pm 4.73\%$ no more samples are needed when $\pm 5\%$ is the desired standard error.
No further analysis needed.
If a σ_E of $\pm 2\%$ is desired then

$$N = \left(\frac{14.2}{2}\right)^2 = 50$$

or 40 more samples are needed.

3. The mean and the standard deviation have now been found. The next step is to determine the reliability of the mean by the Standard Error, σ_E. Using the foregoing information the

$$\sigma_E \text{ is } = \frac{\sigma}{\sqrt{N-1}} = \frac{14.2}{3} = \pm 4.73\%$$

The mean lies within $\pm$ 4.73%. This is usually written 42.0% $\pm$ 4.73%. This falls within the required $\pm$ 5% and is sufficient.

4. If it is desired that the mean lie within a range of $\pm$ 2% or $\pm$1%, the following procedure is followed, which determines the number of samples necessary to attain this degree of accuracy:

$$N = \left(\frac{\sigma}{\sigma_E}\right)^2 = \frac{(14.2)^2}{(1.0)} = 201.6 \text{ or } 202 \text{ samples}$$

necessary for the mean to lie within $\pm$ 1%. Written as follows, 42.0% $\pm$ 1%. If only a standard error of $\pm$ 2% is desired the samples necessary are as follows:

$$\frac{(14.2)^2}{(2.0)} = 50 \text{ samples}$$

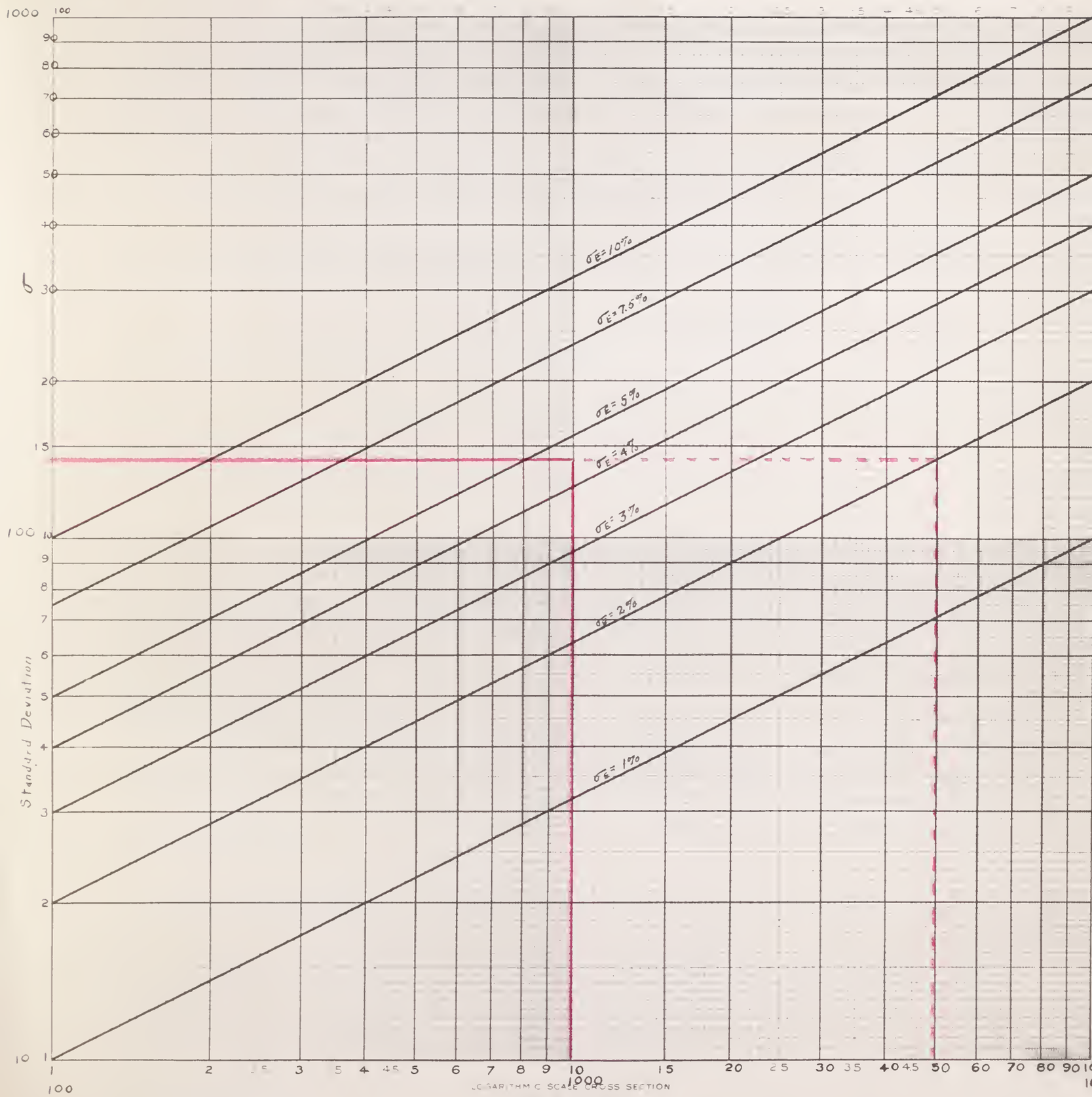
For this work an accuracy of at least $\pm$ 5% must be attained. In some cases it will not be necessary to examine more plots. Also the degree of accuracy desired may be attained before the calculated number of plots have been examined.

The attached chart gives an easy method for determining the standard error and the number of samples required for a given standard error and standard deviation.

1. Locate the standard deviation on the vertical axis on the left hand edge of the sheet. Two scales are given in order to facilitate reading. The inner, printed scale ranges from 1.0 to 100.0, the outer scale from 10.0 to 1000.0.

2. Locate the number of cases (N) on the horizontal scale at the bottom of the sheet. Two scales are again used for convenience. The upper printed scale ranges from 1.0 to 100.0, the outer scale or lower scale from 100.0 to 10,000.0.

CHART FOR THE DETERMINATION OF THE STANDARD ERROR OR THE NUMBER OF SAMPLES NECESSARY FOR A DESIRED STANDARD ERROR.



LOGARITHMIC SCALE CROSS SECTION

3. Locate the point of intersection of the σ and N and read the σ_E from the curves. In the example given follow the solid red lines. The σ_E determined in this manner from the example given lies above the desired example of ± 2% σ_E, therefore, how many samples will be necessary in order to attain a σ_E of ± 2%?

4. Extend the line for σ, in the example the broken red line, to its intersection with the curve designated as ± 2%.

5. Follow down, again the broken red line, to the intersection with the horizontal scale and from this read off the number of samples necessary to give σ_E of ± 2% is 50.0.

6. When the final determination of the standard error is made the results should be written as follows:

$$M \pm \sigma_E, \text{ or } 42.0\% \pm 4.73$$

7. Record on the back of Form #4 in the proper place.

PROGRESSIVE STEPS IN SURVIVAL SURVEYS

In general the progressive steps by which data are obtained for an analysis of planting areas are as follows:

Preliminary Information

Previous to planting a complete planting plan is developed. Part of this plan is in the form of a sketch map which indicates: (1) area boundary, (2) species arrangement, (3) spacing, (4) natural and cultural features of importance and such other significant information as may be desirable.

At the time of planting information as called for is noted on Revegetation Form #4.

Before field survival studies are started, one should decide upon a tentative procedure for sampling the area, select ten or more preliminary samples for study in the initial survey and consider the standard measures to be employed for the sample areas.

Initial Survey

In the field an initial plant survival survey will be made to determine the number of samples needed to secure a standard error of the mean of ± 5%. Not less than ten samples of 25 shrubs or trees each of cuttings or rooted stock will be procured. These samples must be properly distributed over the planting area.

Specifically, the preliminary sample areas will be located on the ground and marked and these locations noted on the sketch map.

After the sample areas have been located, the individuals in each sample are counted and the survival percentage for each sample computed and recorded.

As soon as the ten preliminary counts have been made:

1. Enter the survival percentage in the proper class on the analysis sheet (Revegetation Form #3).

2. Select the "guessed mean".

3. Enter the deviations, plus and minus.

4. Compute the mean, standard deviation and standard error of the mean.

5. If the standard error is in excess of ± 5%, compute the number of samples required to give this standard error.

Final Survey

If additional samples are needed as determined by the initial survey a final survey will be made. This survey includes all samples taken in the initial survey plus the additional samples as required.

Miscellaneous Considerations

So far as practicable all data should be compiled in the field. All information obtained covering sampling, counting and analysis should be so organized that it is clear and understandable, forming together with the planting plan, a fully satisfactory record of what has been done and the survival obtained.

Provision will be made for specific field checks by the District and Regional Office on survival surveys. These are indispensable and should be effected during the progress of the work. The s urveys will be conducted by a member of the District Woodland Management staff or other qualified personnel. The Regional Office will be notified as to the time that these surveys are to be made in order to conduct the above check surveys.

Annual Report

Annually on December 1, each District will send to the Regional Office a report of survival studies carried on during the preceding calendar year. This report should show what areas have been covered to date and a summary of the results obtained, and will form a part of the cumulative planting records.

The annual report will not list species separately, thus it will be necessary to make a survival analysis for each area for all species. Each project or District should include information covering plantings on camp or other areas outside District and project boundaries.

ANNUAL REPORT

District or Project	Season of Planting	Total Acres	Total No. Plants	Satisfactory Survival		To be Replanted		Cost of Stock	Cost of Planting	Cost per Plant Surviving	Survival Studies Cost
				Acres	Average Survival Percent	Acres	Average Survival Percent				
Total by States											

REMARKS:

S.C.S. Reg. 8 Revegetation Form #4
Trees-Shrubs-Cuttings-Rooted Stock

PLANTING RECORD

District _____ Project _____ Sub-project _____
Camp Area _____ Land Mgt. Unit _____ Owner _____
Planting Area _____ Location _____

Reconnaissance by _____ Date _____
Purpose _____

SOIL

Surface _____
Structure _____ Texture _____
Depth _____ Reaction _____
Organic Matter _____ Moisture _____
Subsoil _____
Texture _____ Structure _____
Reaction _____ Moisture _____
Depth _____ To Imper. Layer _____

COVER

_____ % _____ %
_____ % _____ %
_____ % _____ %

Area _____ Acres Map No.* _____
Exposure _____ Slope _____
Rodents _____
Remarks _____

Approved by _____
Soils Section Name Date

Supervised by _____ Date Planted _____
Planted by _____
Soil - Condition _____ Moisture _____
Treatment _____ Other _____
Climatic Conditions _____
Sun _____ Wind _____ Rain _____
Temperature _____ Other _____

Planting Method _____
Stock Type _____ Age _____ Quality _____
Source _____ Spacing _____
Care of Stock _____
Protection _____
Engineering _____

Rodent Control _____

Row No. or Unit Area	SPECIES	No. of Plants Est.	No. of Plants Act.

*Attach a sketch map of the planting area.

PLANT SURVIVAL RECORD

DATE	SPECIES									RAINFALL RECORD	
										MEAN ANNUAL "	
										DATE	INCHES

JOURNAL REMARKS

	No. of Plants	No. of Acres	Sat. Surv. Acres	Sat. Surv. Mean Sur. %	To be Replt. Acres	To be Replt. Mean Sur. %	Cost per Plant	Cost per 1000	Cost per Survival	Cost per 1000
Original										
Replant.										

Item	Cost
Planning	
Engineering	
Soil Treatment	
Rodent Control	
Planting Stock	
Transportation	
Planting	
Other	
TOTAL	
Survival Survey	
Replanting	
TOTAL	
GRAND TOTAL	

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PART II

SEEDINGS

INTRODUCTORY

Purpose of Survival Surveys

For policy refer to Part I. These surveys will provide basic information on justification and survival which will in part allow the reasoned development of future revegetation by direct seeding.

Object of the Work

The object of this phase of plant survival survey work is to obtain information: (1) concerning the justification of direct seeding, (2) germination and survival of plantings as related to the species, quality of seed, soil treatment, costs, and various other factors, and, (3) to determine the point where replanting is justified or feasible.

The use of statistical methods will save time and money in securing usable information on plant survival.

Coverage

Where adequate data are available, only seedings of those types which now appear justified in the light of the primary purpose of the planting as stated should be checked by survival surveys. All future plantings will be subject to study except where many plantings of one type occur under uniform conditions within a given locality. Here a mechanical selection of sufficient individual planting areas should be made. Survival studies of these selected areas will give a reasonable cross section of survival for the locality.

Kind of Data to be Collected

Refer to Part I.

Intensity of Field Work

The initial survey for broadcast seeding will cover 25 samples of 100 square feet each, well distributed over the area. The final count, if needed, should cover the area in more detail, the number of samples depending upon the accuracy required. The final standard error of the mean for broadcast seeding will be ± 0.05, using density as the unit measurement. For drilled seedings or row seedings the density per 100 lineal feet of row will be determined. For spot seeding the standard error of the mean will be $\pm$ 5 units or $\pm$ 5% for the trees and shrubs or ± 0.05 for grasses and forbs.

Plantings of over one acre in extent will be treated statistically, areas smaller than one acre will be completely covered. These small areas must be isolated and not directly related to any other planting.

Survival surveys will be made at the end of the second growing season but before the plants have dried. For trees and shrubs it will be best to start the survey the first season after planting and before the leaves have fallen.

SAMPLING

Methods

Refer to Part I.

The gridiron method is the most feasible method of selecting samples over large areas over which conditions are essentially the same. The area to be studied may be gridironed as in Figure 1, the dots denoting the point of intersection and the squares the 100 square foot samples.

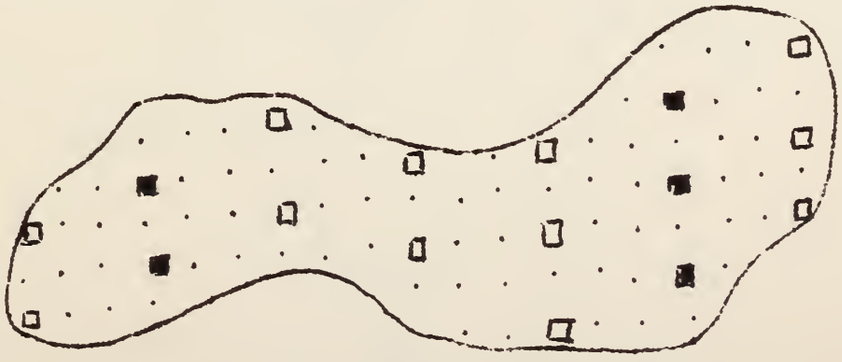

Fig. 1

The darkened squares indicate the additional sampling required for the final survey.

Fig. 2

Figure 2 illustrates a method of sampling rows or for taking samples along lines. The cross bars and heavier line indicates the sample, one hundred lineal feet or 100 square feet. Additional samples should be located mechanically as shown by the crosses.

On engineering structures the samples should be taken at right angles to the axis of the structure.

Fig. 3

Where a series of structures are to be studied the samples may be taken as follows:

Fig. 4

In the above plantings the sample areas will vary in size, the bands should be at least five feet wide and should extend from one edge of the planting to the other edge in order to take in all conditions. The density of the s tand will be the unit of measurement.

. Spot seeding may be handled in three ways, by density, by actual survival, or by considering the establishment of a single plant as a

success. For grasses and weeds density will constitute the unit of measurement; for trees and shrubs the actual survival or the establishment of a single plant, the latter preferred. A number of seed spots should be marked at the time of planting for future reference. These should receive no treatment other than that given to the majority of spots. At least 25 samples should be taken for survival studies.

Figure 5 gives the most feasible method of sampling an area where the seeding has been in small spots.

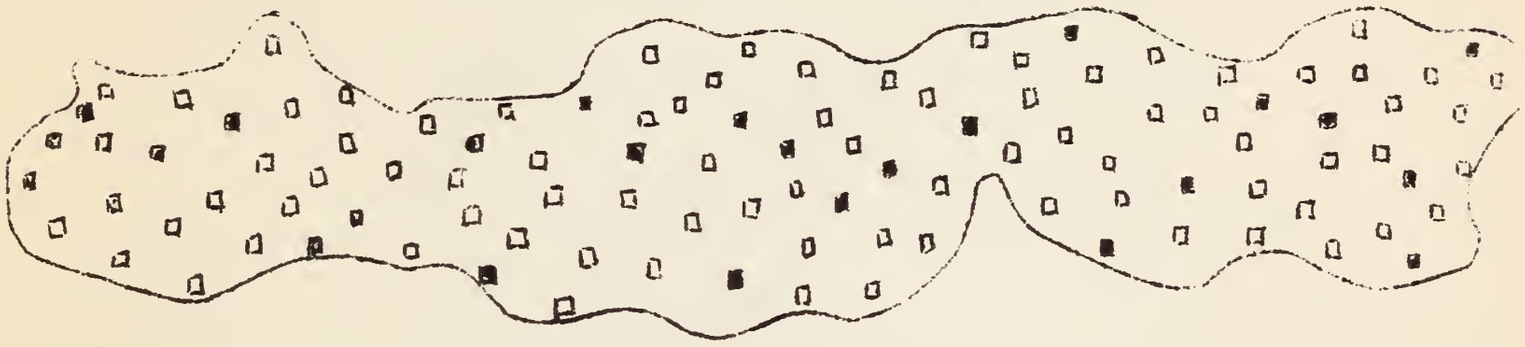

Fig. 5

The blackened spots indicate the samples taken, further samples must be located mechanically over the entire area.

Analysis of Results

Refer to Part I, "Analysis of Results" for method of computations except for trees and shrubs as given below.

For spot planting of trees and shrubs the system of computations must be changed when one plant per spot is considered a success. The following formulae will be used:

M = Mean or average

N = Number of spots examined

P = Number of successes as per cent of total

F = Number of failures as per cent of total

σ = Standard Deviation = $\sqrt{NPF}$

σ_E = Standard Error = $\sigma_E = \frac{\sigma}{N}$

Example:

15 spots show living plants

10 spots show no plants

$N = 25$

$P = \frac{15}{25} = 0.6$ $\qquad F = \frac{10}{25} = 0.4$

$\sigma = \sqrt{25 \times .6 \times .4} = \pm 2.5$ or $\frac{2.5}{25} = \pm 10\%$

$\sigma_E = \frac{2.5}{25} = \pm 0.1$ or $\frac{.10}{25} = \pm 0.4\%$

Mean = $60\% \pm 0.4\%$

Note: The chart in Part I cannot be used for the determination of the standard error or the number of cases needed to reach a desired standard error.

PROGRESSIVE STEPS IN SURVIVAL SURVEYS

In general the progressive steps by which data are obtained for an analysis of planting areas are as follows:

Preliminary Information

Previous to planting a complete planting plan is developed. Part of this plan is in the form of a sketch map which indicates: (1) area boundary; (2) species arrangement; (3) spacing of spots; (4) natural and cultural features of importance; and such other significant information as may be desirable.

At the time of planting, information as called for is noted on Revegetation Form #4A.

Before field survival studies are started, one should decide upon a tentative procedure for sampling the area, select 25 or more preliminary samples for study in the initial survey and consider the standard measures to be employed for the sample areas.

Initial Survey

In the field an initial plant survival survey will be made to determine the number of samples needed to secure a standard error of the mean of ± 0.05, ± 5 units, or ± 5%, depending upon the measure used. Not less than 25 samples will be secured. These samples must be properly distributed over the planting area.

Specifically, the preliminary samples will be located on the ground, marked, and these locations noted on the sketch map.

After the sample has been located, the density, number of individuals or success of the sample is noted and recorded.

As soon as the preliminary sampling has been made:

1. Enter the density, per cent survival, or number of plants on the analysis sheet (Form #3) in the proper column.

2. Select the "guessed mean".

3. Enter the deviations, plus and minus.

4. Compute the mean, standard deviation and standard error of the mean.

5. If the standard error is in excess of the ± 0.05, ± 5 units or ± 5%, compute the number of cases required to give this standard error.

Refer to the section on "Analysis of Results" for procedure where only successes are recorded.

Final Survey

If additional samples are needed as determined by the initial survey a final survey will be made. This survey includes all samples taken in the initial survey plus the additional samples required.

Miscellaneous Considerations

So far as practicable all data should be compiled in the field. All information covering sampling and analysis should be so organized that it is clear and understandable; forming together with the planting plan a fully satisfactory record of what has been done and the survival obtained.

Provision will be made for specific field checks by the District and Regional Office on survival surveys. These are indispensible and should be effected during the progress of the work. The surveys will